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# DESIGN AND CONSTRUCTION OF A MAGNETIC-TAPE TESTING MACHINE

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## ABSTRACT

A machine for testing magnetic recording tape was designed and built to provide a capability for investigating the effects on tape performance of wrap angle, speed, tension, temperature, atmospheric conditions, and other variables. This machine will be used to investigate spacecraft tape problems and the relative performance of magnetic tapes under prescribed spacecraft operating conditions.

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# DESIGN AND CONSTRUCTION OF A MAGNETIC-TAPE TESTING MACHINE

by

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## INTRODUCTION

Tape recorder problems have recently become critical in the design and construction of high reliability, long-life scientific satellites. The problems encountered have included drive belt failures, bearing lubrication problems, seal problems, and, more recently, an intermittent high-friction condition between the tape and the magnetic heads which seems to be related to the tape binder. Logical solutions to this last problem were either to improve the existing binders (i.e., use higher curing temperatures, UV, or other radiation to cross-link the binder more completely), or to develop better binders. Either of these approaches, or other alternate approaches, requires a method for evaluating any improvement in the tape. It is this requirement which the machine described herein satisfies.

Existing tape evaluation methods consist of running the tapes in flight-type recorders for prescribed lengths of time under controlled environmental conditions. This method is time consuming and does not lend itself to large volume testing or to investigation of the effect of test variables (e.g., the effects of different magnetic-head materials and environments on the friction behavior between the head and tape).

The goal of the test machine design was to permit investigation of the performance of magnetic recorder head and tape materials as a function of tape speed, tension, wrap angle, temperature, atmospheric conditions, and any other variables that may arise. At a minimum, the machine was to provide a capability of testing eight tape samples simultaneously. The final design incorporated these systems:

1. A drive system to pull the tape back and forth over simulated tape recorder heads
2. A system to measure the friction developed between the tapes and heads
3. A temperature control system
4. A dead weight system to provide controlled tape tensions
5. A controlled atmosphere chamber.

## COMPONENTS OF THE BASIC MACHINE

Each of the systems listed above and their performance limitations will be described.

### Drive System

The drive system (Figure 1) consists of a combined takeup-reel drive-roller plus two idler rollers driven by a reversible 24-volt dc motor. The motor rotates the drive roller first in one direction and then the other. Reversal of rotation is accomplished by microswitches that actuate an electronic switching delay device that provides approximately a 3-second delay between starting and stopping the drive motor; this prevents transient loads on the tape when rotation is reversed. A range of tape speeds from 1 to 10 ips can be accomplished by simple gear changes. Other speeds can be obtained by the simple substitution of a higher or lower speed drive motor.

### Friction Measurement System

The friction between head and tape is measured by a strain-gauge torque arm that operates as follows: The test heads are attached to a centrally located shaft supported by bearings; the rotation of the test head is opposed by the calibrated strain-gauged cantilever arm that measures the torque imparted to the head. Type C6-141 temperature-compensated strain gauges were employed. The output of each of the eight strain-gauged torque arms is fed into a 10-position stepping switch which is fed in turn into a recorder that continuously records the tape-to-head friction. Detection of changes in torque of less than 0.25 inch-ounce is possible.

### Temperature Control System

A range of temperatures from ambient to 150° F is provided by four resistance heaters controlled by individual variacs; temperature uniformity is achieved by forced air circulation. Results of a temperature survey, up to 140° F, show maximum temperature variations to be less than  $\pm 3^\circ$  F; temperature fluctuations of the test tapes and heads are considerably less than this.

### Dead-Weight Tape Tensioning System

Tape tension is provided by dead weights attached to the tapes. The dead weights are positioned by dual music wire guides that assist in tracking of the tape over the head. The range in

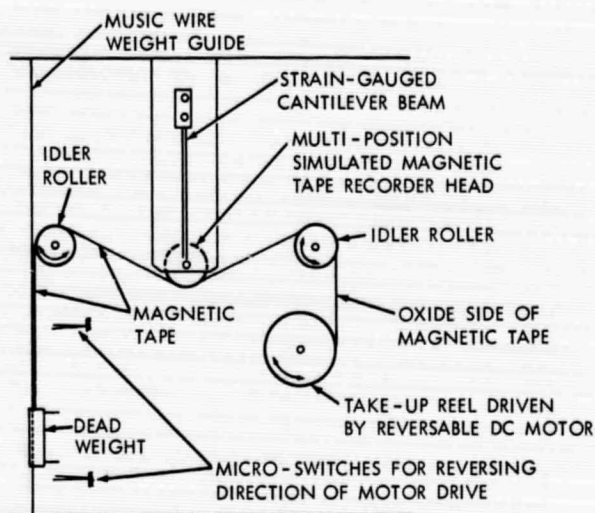


Figure 1—Schematic diagram of the tape testing machine.

tension loads varies from a minimum of 3 ounces (the tare weight) to a maximum limited by the drive motor capability. Tension loads up to 1 pound have been employed with no difficulty.

## Atmosphere Control System

The tape machine is completely enclosed thus allowing the introduction of artificial atmospheres if desired.

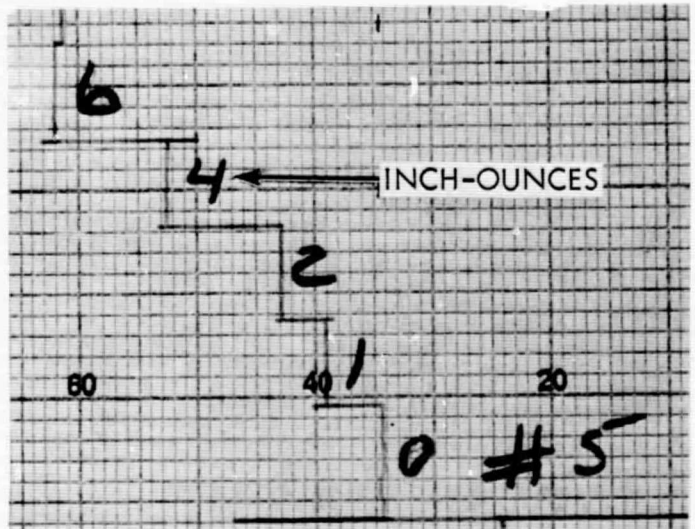
## SUMMARY OF TEST RESULTS

Tests conducted to date have been primarily directed at characterizing the capability of the tape testing machine itself. Test details and significant results are presented below.

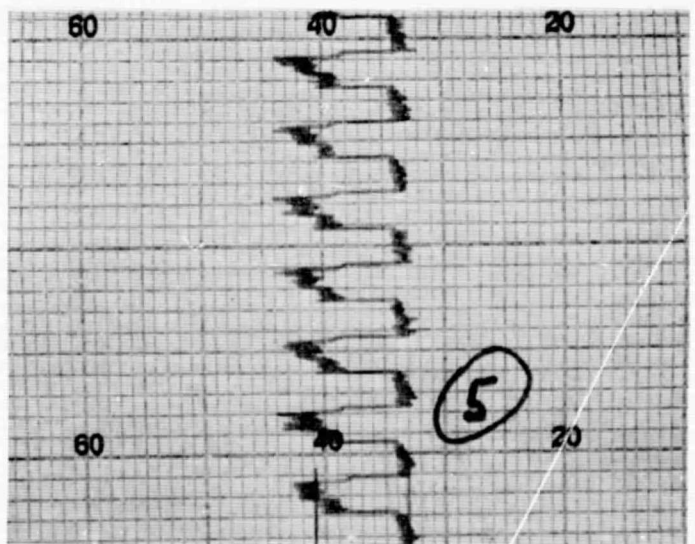
Eight test samples of 3M-551 tape were assembled on the machine and run for 10,000 cycles. A wrap angle of 23 degrees, a tension load of 7 ounces, and a tape speed of 0.9 ips were employed. The test was conducted under ambient temperature and atmosphere. Results established the machine to be capable of long-term tests with only periodic operator attention. Figure 2 presents typical torque traces and calibration curves for the torque arms obtained during this test.

To establish the degree of temperature dependence of the torque arm outputs, the torque arms were calibrated at both room temperature and at 140° F. Figure 3 presents the calibration results obtained. The effect of temperature on gauge output is considered negligible from room temperature to at least 140° F.

To investigate the relationship between wrap angle and friction, tests were conducted in which the wrap angle was varied from 10 to 50 degrees. For



(a) Calibration of channel 5 torque arm strain gages;



(b) Torque record from channel 5 (10,000 cycle test) numbers represent equivalent inch-ounces.

Figure 2—Typical response from tape test machine torque arm.

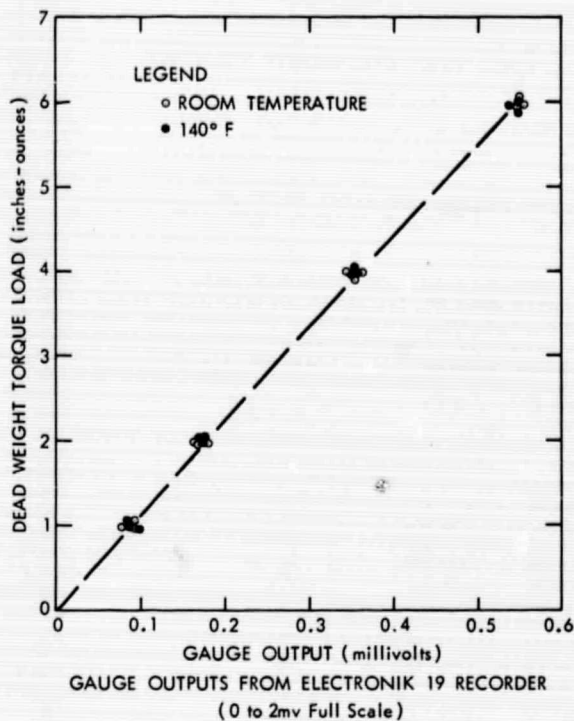


Figure 3—Torque arm calibration as a function of temperature.

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these tests 3M-551 tape was used, the tape speed was 0.9 ips, 0.75-inch diameter brass heads were employed, and the tests were conducted at ambient temperature and atmospheric conditions. The results are presented in Figure 4.

Results of tests conducted to date have shown that the tape machine, as designed, will permit investigation of the performance of magnetic tapes under a wide variety of test conditions.

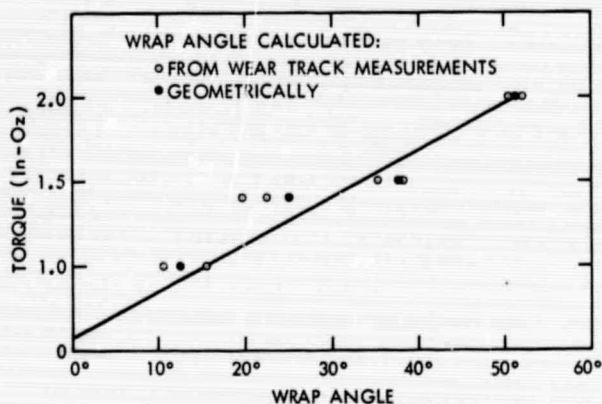


Figure 4—Friction as measured from the torque arm outputs versus wrap angle.